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Implementing Filters to Identify and Prioritize Industrial Base Risk: Rules of Thumb to Reduce Cognitive Overload

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In 2012 and 2013, the Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy (ODASD[MIBP]) implemented a methodology for measuring the criticality of key products and technologies (technology criticality), and their fragility within the industrial base (vendor fragility). During 2013, pilot assessment projects of selected DoD programs and sectors applied this methodology to measure nine constructs of technology criticality and six constructs of vendor fragility. While the 2013 pilots were completed in six months or less, we recognized that the time spent identifying the assessment issues and industrial base capability was still too long to be completely responsive to management information needs. In 2014, we explored guides for prioritizing the capabilities that are taken forward to the assessment teams and refined and categorized the filters used to reduce the amount of time devoted to this activity. Our goals were to reduce the overall amount of time to complete our assessments and to be proactive in identifying emerging issues, and agile in responding to existing ones.

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Implementing Filters to Identify and Prioritize Industrial Base Risk: Rules of Thumb to Reduce Cognitive Overload

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Abstract

In 2012 and 2013, the Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy (ODASD[MIBP]) implemented a methodology for measuring the criticality of key products and technologies (technology criticality), and their fragility within the industrial base (vendor fragility). During 2013, pilot assessment projects of selected DoD programs and sectors applied this methodology to measure nine constructs of technology criticality and six constructs of vendor fragility. While the 2013 pilots were completed in six months or less, we recognized that the time spent identifying the assessment issues and industrial base capability was still too long to be completely responsive to management information needs. In 2014, we explored guides for prioritizing the capabilities that are taken forward to the assessment teams and refined and categorized the filters used to reduce the amount of time devoted to this activity. Our goals were to reduce the overall amount of time to complete our assessments and to be proactive in identifying emerging issues, and agile in responding to existing ones.

Background

The Department of Defense (DoD) faces two kinds of risk in the industrial base—voluntary and involuntary. Involuntary risk is incurred from external influences such as the Defense procurement budget, congressional mandates, and emerging national security threats. Each of these influences impacts DoD decisions on amount and type of activity that is distributed among the predominant factors of research and development, acquisition, and sustainment.

Voluntary risk arises from the consequences of decisions within the Department's sphere of influence. This includes decisions about when and how the Department will rely on market forces to create, shape, and sustain industrial and technological capabilities, as well as how it will intervene when absolutely necessary to create or sustain essential industrial capabilities.

During the Korean War, DoD investment outlays comprised over 5% of total gross domestic product (GDP), sustaining a strong symbiotic relationship with U.S. industry of

earlier eras. The influence of defense investment outlays has dropped since the late 1980s to less than 2% of GDP, with a concentration of certain industries, globalization of markets, and increased export markets. The simple fact of having a private sector industrial base, frequently international, that is largely outside of the DoD's control reduces the Department's options for risk mitigation. However, that limitation is only a minor deterrent to action.

Before we can implement any mitigation actions, we must first identify the action as a solution to a known industrial base deficiency. Before an industrial base deficiency can be known, we must be able to compare defense requirements to industrial base capabilities. Before we can compare industrial base capabilities to requirements, we must have visibility into capabilities of individual product and service providers and their supplier networks.

In 2008, the Government Accountability Office reported that the DoD's efforts to monitor its supplier base lacked a Department-wide framework and consistent approach. The report noted that (a) DoD monitoring efforts generally respond to individual program supplier-base concerns or are broader assessments of selected sectors; (b) the DoD uses an informal approach to identify supplier-base concerns, often relying on the military services, program offices, or prime contractors to identify and report these concerns, including gaps or potential gaps; and (c), since no requirement for which to report such gaps to higher-level offices exists, knowledge of defense supplier-base gaps across the DoD may be limited.

In 2011, the Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy (ODASD[MIBP]) was tasked with developing a forward-leaning approach that could identify the cumulative effect on vital capabilities of procurement decisions across programs and services. We built on an existing 1996 framework to develop a methodology that could be used proactively, across services and industrial sectors, that is rigorous, repeatable, and transparent. The process became known as the Sector-by-Sector, Tier-by-Tier Fragility and Criticality (FaC) assessment process, or FaC for short.

The results of the pilot effort conducted through summer 2013 and the methodology were presented at a research conference in May 2014 (Sleeper, Starns, & Warner, 2014). The 10 FaC pilot assessments identified important risks in the industrial base and provided actionable mitigation strategies to DoD leadership. The pilots assessed sectors and programs in diverse life-cycle phases, for example, development, production, and sustainment. Data collected from surveys, datasets, reports, and industry subject matter experts were used to assess the measures for capability/supplier pairs. Empirical and statistical analyses indicate that the methodology yields useful objective measures of risks in the industrial base.

The pilots also provided lessons on how to improve the overall FaC process. One such process improvement is the use of filters that are adaptable that can be used to isolate areas where risks may be present in the industrial base to the delivery of support to the warfighter. To achieve this goal, we need to institute guides for prioritizing the capabilities that are taken forward for fuller resource-intensive assessment. The November 2013 document, Assessing Defense Industrial Capabilities: A DoD Guide to DoDI 5000.60 (hereafter referred to as the Guidebook; DoD, 2013), provides a framework to determine the need for government action to preserve industrial capabilities vital to national security. This paper presents an approach about how to apply criteria in the Guidebook and additional filters as "rules of thumb" to reduce the amount of time devoted to identifying and prioritizing areas of the industrial base for deeper dive assessments.

Overview of the FaC Process

The DoD tested the FaC assessment process by completing 10 pilot FaC assessments in 2013 that included a mix of sectors and skill areas. From these pilots, the DoD refined the process and the resulting high-level overview, presented in Figure 1. The process is designed to be iterative and provide continuous expansion of the DoD's insight into industrial base capabilities and constraints.

The first activity is to *select the assessment subject and scope*. The assessment generally begins by choosing an industrial base sector or subsector within that sector. However, as additional insight is acquired, future iterations may focus on more limited technology or commodity areas. Selection of a program or sector for a FaC assessment is based on leadership priorities, industrial base analysis, and the results of prior industrial base assessments.

A functional- or component-based taxonomy of the sector is used to scope assessment. Sectors, subsectors, and programs intersect in a number of ways, and the taxonomy provides the boundary for what is in or out of scope for a particular assessment and highlights where future efforts might focus. The taxonomy is instrumental to identify the sub-tier markets that comprise the sector, and to decide when to go broader or deeper in a subsequent iteration.

The second activity in the process is to **search for data and filter out non-industrial base issues** to support industrial base assessment. In today's resource-constrained environment, the analyst cannot afford to conduct an open, unbounded search for information. Once the assessment scope is selected, industrial base analysts evaluate available data sources for potential inclusion in the FaC assessment. Specific program or sector and supplier information included in existing databases, tools, programs, and so forth is identified through the FaC criteria lens.

Process Activity	Action	Outcome
Select Sector/SubSector	Scope the problem (existing risk assessments; program shutdowns)	Sector Taxonomy
Search Available Data	Identify IB-related risks & related capabilities/products Identify suppliers and market	Potential IB Risks/Issues
FaC Screening/Filtering	Focused set of IB-related risks for further assessment	Screened IB/Issues Capability-Supplier Pairs
Conduct FaC Matrix Assessment	Facilitated scoring, based on standardized criteria, by SMEs	FaC Risk Matrix
Validate & Mitigate High Risk IB Issues	SME "deep dive" into IB risk areas; facility visits	Solutions to High Risk IB Issues

Figure 1. FaC Assessment Activities, Actions, and Outcomes

A DoD platform can have thousands of components and integrated subcomponents, require specialized skills, and draw upon numerous vendors below the prime contractor. An

industrial sector has even more—so many that it would be impractical to evaluate all of the components, skills, technologies, and vendors in any single assessment. Accordingly, before conducting a FaC assessment, the analyst applies filters to arrive at the target set of capabilities and vendors. The filtering activity is essential to the FaC process: Filtering rids the assessment of non-industrial base issues, and it protects against data overload by focusing efforts on areas with a higher potential of concern to the DoD.

While some filters were used in each pilot assessment, additional filters tailored to the sector or program under investigation were also employed. Since the focus of the assessment is to identify risks in the defense industrial base, a crucial task is to weed out risks that, while important, are not important to the industrial base. Specifically, program-related supply chain issues do not necessarily impact the industrial base. Accordingly, one of the screens applied to each capability is whether it is relevant to many platforms and services. If the answer is no, there may be risk in the supply chain for the capability, but it is not necessarily a risk in the industrial base since mitigation efforts are appropriately handled by the prime vendor or program office affected by the issue.

The result of the data collection and filtering activity is a winnowed down set of capability-supplier pairs that are moved forward for the formal FaC assessment. In the assessments, a capability required from the industrial base is defined as a technology, part, component, or product. A supplier is defined as the current provider(s) of that capability. A capability, then, might be as small as an individual part, as large as an integrated subcomponent, or a specialized activity. Each capability is then paired with its current suppliers, and each capability-supplier pair is assessed separately. Accordingly, the same capability may be associated with multiple suppliers, and a single supplier may be associated with multiple capabilities.

The third activity is to **conduct the FaC assessment**. The heart of the assessment process is the set of criticality and fragility criteria that serves as indicators of potential industrial base-related risk. Criticality, from an industrial base perspective, consists of indicators to identify when a capability would be difficult to replace if it was lost or disrupted. Fragility indicators focus on the robustness of current suppliers of a capability and the availability of potential firms in the current marketplace. The fourth activity is to **validate high-risk industrial issues and develop mitigation strategies**.[1]

Filters and Screens: Narrowing the Field

The FaC assessment process includes filtering steps to try to focus quickly on areas most likely to contain issues of interest to the DoD. Analysts can then focus their efforts on assessing and validating a small number of capabilities in a sector to determine which ones require further analysis, continued observation, or immediate mitigation. The findings and recommendations on possible mitigation strategies are then presented to leadership.

Filters are used in many settings. Here we use them to sift through mountains of information and capture the capabilities in the industrial base that are required by the DoD, but may be at risk for any number of reasons. The use of filters, or screens, is akin to

[1] While the core of the FaC process is the application of the formal set of criticality and fragility criteria in the third activity, the previous working paper, which is available from the authors, documented this part of the process.

medical triage where patients are sorted quickly based on observed criteria associated with severity, and then further triaged and prioritized within the initial group using finer-grained sets of criteria, and, depending on resources available for treatment, screened again to prioritize mitigation and intervention actions. In the medical triage example, the patients who are not critical enough to make the first (or second or third) stage may have injuries or illness that need to be treated, but these are deferred and prioritized for subsequent assessment and treatment.

When filtering is applied to the industrial base, the range of capabilities that may be at risk, and which can cause severe impact to the DoD, exist in an environment of components, technologies, and activities. The application of standard screening criteria serves to highlight at-risk capabilities, as well as illuminate the nature of the risk based on the criteria and severity. That is, like the medical triage example, the screening criteria can help assign priority order to mitigation and action on the basis of where funds and other resources can best be used, are most needed, or are more likely to achieve success.

Taxonomies: The First Step to Scoping the Assessment

Industrial base assessments may be triggered by an emergency or emergent alert or a routine evaluation of the health of an area of the industrial base. Emergency or emergent topics assessments may be prompted by any number of questions posed by leadership or industry, change in circumstances by a source of supply, or programmatic changes, for example. Typically these assessments are conducted within constrained timeframes and must provide defensible recommendations for action. At first glance, it may appear that the scope of the assessment is defined by the emergent topic. However, like the medical triage case, the industrial analyst has to wade through the number of at-risk and potentially at-risk areas quickly and efficiently to focus assessment resources on the likely areas. Further, the use of structured criteria help to transmit to leadership and other stakeholders how and why risk areas were included or eliminated for consideration.

Having taxonomy for each industrial assessment is essential as it provides a scoping mechanism. At any point in an assessment, the analyst should know how much of a sector is being evaluated. Because the FaC is designed to be an iterative process, the taxonomy is instrumental in deciding whether you need to go broader or deeper in a subsequent iteration. As previously noted, the taxonomy establishes the boundary of a system so that the assessment team will know how much of the system that they have evaluated. Every assessment is limited by time, resources, and available information.

In general, although by no means universal, the first assessment of any system or sector will focus on the assembly or functional levels of the system. During any FaC assessment, the team may discuss items where, by common agreement, not enough information is available to make a judgment. When that occurs, the assessment lead may elect to conduct a second assessment to probe deeper into lower levels of the taxonomy (see Figures 2a and 2b).

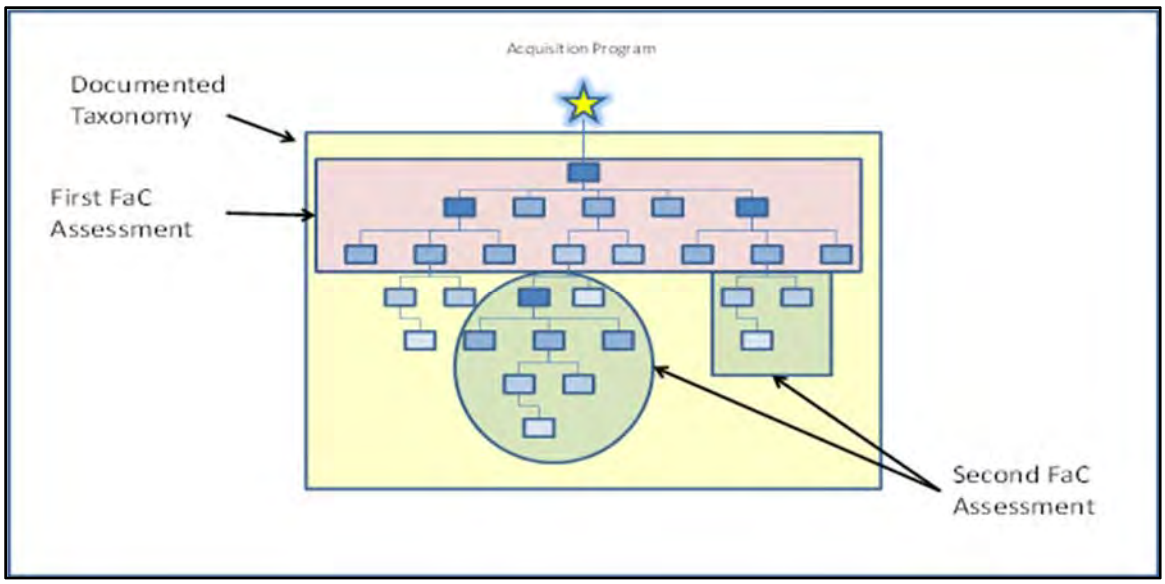

Figure 2. (a): Application of Taxonomy to Bound Assessment Activities

In some instances, there may be considerable knowledge about a system's components. So the FAC lead would evaluate previous reports and studies and target portions of the taxonomy for a FaC assessment.

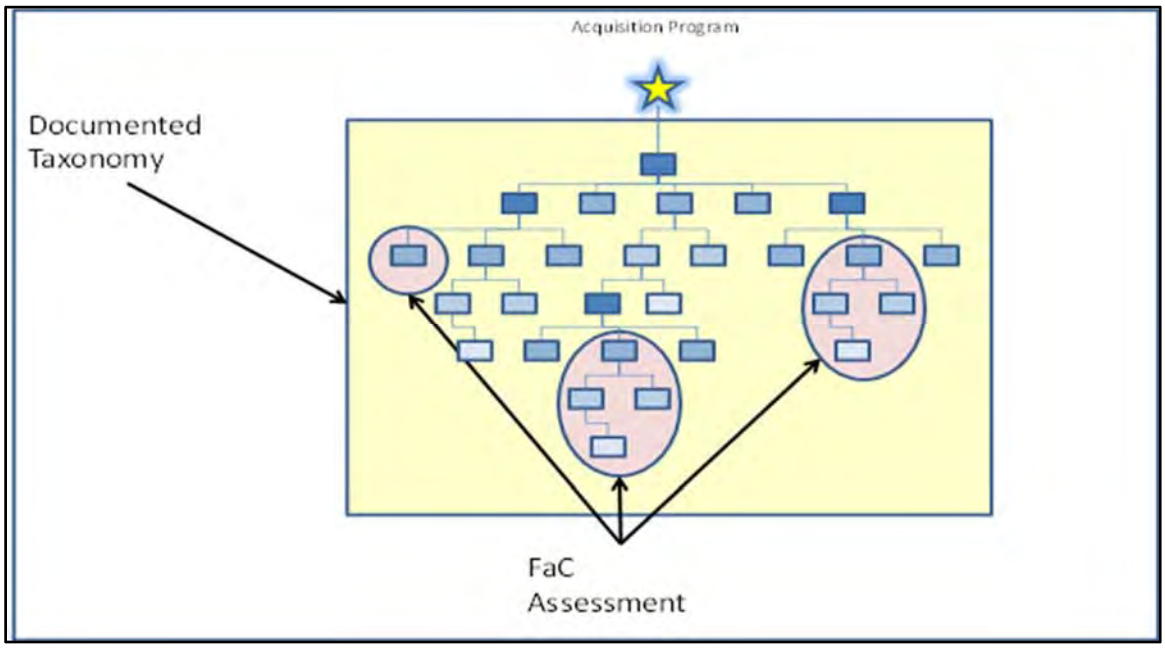

Figure 2 (b): Application of Taxonomy to Bound Assessment Activities

Example: A High-Level Filter for Isolating DoD Industrial Base Areas of Concern

While the industrial base is composed of vendors, the risk to the DoD is disruption of supply of a capability, not disruption of a particular vendor. That is, it is the supply of the products, services, and skills that is assessed independent of who is the current supplier. Accordingly, the areas of potential risk focus on characteristics that make a particular capability difficult to replace if it is disrupted, not on characteristics about a firm.

The Guidebook provides the framework for the screens used to triage areas of potential risk in the industrial base. We employ the framework to sort through the capabilities in rapid fashion to identify those that demonstrate important risk characteristics. It is important to note that, like medical triage, the screens prioritize areas for further review—an area that does not meet the criteria does not mean that there is no issue, but rather that they lack the high-level indications associated with increased risk. As with any rack-and-stack process, maintaining a record of each screen is essential to the process.

The screens are not intended for **routine vendor management problems**. As outlined in the Guidebook, vendor management problems are mitigated when a direct substitute product or service is available by another supplier that is willing and able to provide it within a reasonable time and price. Once these are eliminated, a high-level screen can be applied as a "thumbs-up/thumbs-down" check against the selected taxonomy to begin to identify areas of possible concern. For example, characteristics of a high-level filter relevant for the DoD generally include the following:

- Operational impact of capability (pervasiveness across the DoD or platforms)
- Low commercial market demand (few or limited applications)
- Change in DoD demand expected over the FYDP (up or down)
- Rapid rate of technical change expected (rapid advancement or obsolescence)
- Limited sources of supply (domestic, foreign)
- Anticipated future generation system requirements (next-gen)

We apply the first screen to an Aircraft Sector Taxonomy presented in Figure 3 for two functional areas: Propulsion-Engine and Subsystems-Ejection System.

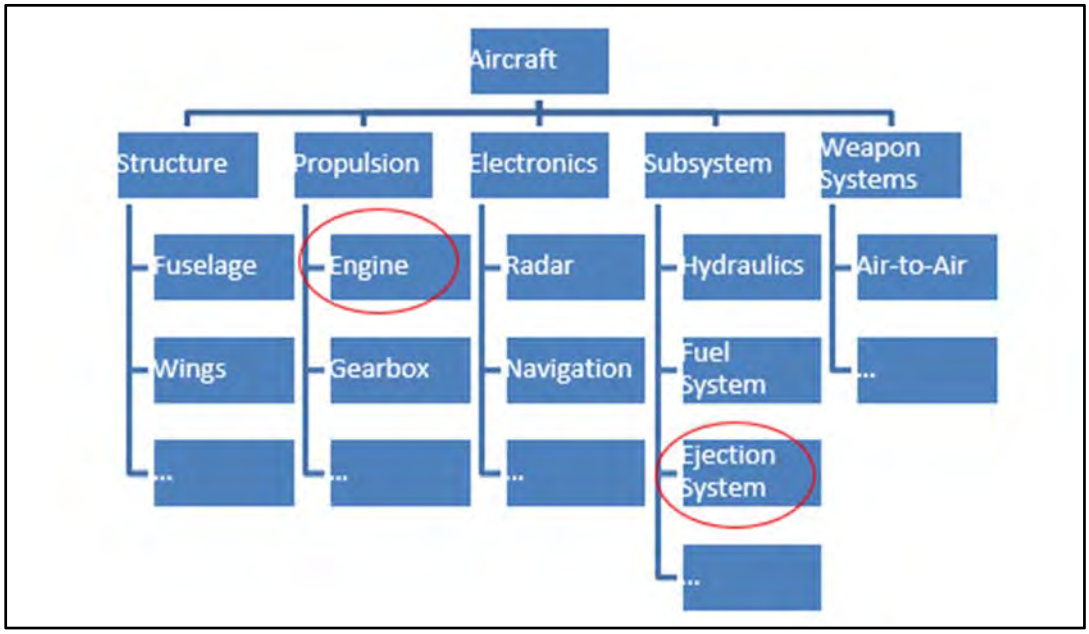

Figure 3. Notional Aircraft Taxonomy

Table 1. High-Level Screen for Aircraft Ejection System and Engine

High-Level Screen	Subsystem: Ejection System	Propulsion: Engine
Operational impact of capability	Yes: multi-service requirement–operational impact of capability cross-DoD	Yes: multi-service requirement–operational impact of capability cross-DoD
Low commercial market demand	Yes: primarily defense market	No: commercial market for aircraft engine; Yes: tactical aircraft have specialized requirements
Change in DoD demand expected over the FYDP	Yes: overall procurement decrease; no requirement for UAV	Yes: overall procurement decrease
Rapid rate of technical change expected	Unknown: technology evolves to improve survivability—neither rapid nor slow	No: next generation requirements will drive change; not commercial or current DoD demand
Limited sources of supply	Yes: decreasing DoD demand and limited commercial demand may limit sources	No: commercial market for aircraft engine; Yes: tactical aircraft have specialized requirements
Anticipated future generation system requirements	Unknown/yes: next-gen aircraft likely to require advanced systems	Yes: next-gen tactical aircraft likely to require advanced systems

The preponderance of "yes" indicators for Ejection System suggests a closer look. Just like a medical triage, it is the location and severity of "symptoms" that direct our attention, rather than a hard-and-fast rule on the number of positive tick-marks. In the example for ejection systems, the combination of answers illuminate the potential reasons for concern including a marked demand decline of a defense specific system, a system resident on a broad number of platforms, and one procured from a limited set of suppliers. Note, however, that while the triage suggests further investigation*, it does not indicate any specific area of risk.* Further filters, described in the Guidebook, are applied to identify whether an assessment is warranted.

In contrast, a review of aircraft engines suggests declining DoD demand, but a robust commercial market. The high-level filter would indicate this segment receives a lower priority than, for example, ejection systems, all else being equal. However, all else is not equal if the review is aimed at tactical aircraft, which have limited commercial analogs and continuous next-generation technology improvements. In this case, the analyst would apply another set of filters to identify whether an assessment is warranted.

Refining the Scope

Based on the rapid assessment above, we might rank potential areas of concern in order from ejection system, engines for tactical aircraft, and other commercially-similar aircraft engines, and apply resources for deeper dives accordingly. The next level of triage would examine a more detailed taxonomy for ejection systems against an increasingly focused set of filters from the Guidebook.

Digging down further into the example of the ejection system, a new taxonomy emerges. The top level of the taxonomy appears very much like that for aircraft: structure, electronics, propulsion, and C4I, for example. An assessment of the system includes not only the integrator of the subsystems, but also sub-tier suppliers of components and skills. Filters are applied at every level to begin to identify where potential issues might reside, namely, identifying those capabilities that could be difficult to reconstitute if they were lost.

Example: A High-Level Filter Based on DoD Trends

Another high-level screen is based on DoD funding to investigate involuntary risk incurred from changes in the Defense procurement budget. We use two views to begin to capture areas of potential concern. The first is a traditional sand chart to observe trends in the amount of funding for a sector for procurement and research and development. Sharp changes or steady incline, up or down, reveal areas for examination. The other is a view of existing and planned programs over time, independent of quantity, to look for gaps that could have an impact on capabilities in a particular sector.

In the notional graphics presented in Figure 4, existing programs in a sector are displayed in two ways. The top graphic shows funding allocations by program over time. This example shows a steep buildup for some programs, followed by a sharp decline in all programs. Budget requests in the out years suggest funding increases, but these are not yet appropriated. The bottom graphic shows current and planned programs arrayed by their phase of procurement, sustainment, and development. We note (in this hypothetical example) that there are no currently funded programs in development, little new production, and some sustainment activity. One conclusion from the graphic is that engineering and design skills may not be exercised sufficiently; that is, the absence of new program starts or funded future programs may lead industry to divest itself of skills used in the design of next generation systems. In itself, this is insufficient for mitigation action. However, the observation creates a flag for a possible deeper dive into a skills assessment. Similarly, if there were no plans for next-gen technology based on an existing product of service, the absence of new programs would not raise a flag for development activities. Yet, in this case, the lack of production programs could signal an upcoming issue of obsolescence, which would need to be evaluated further.

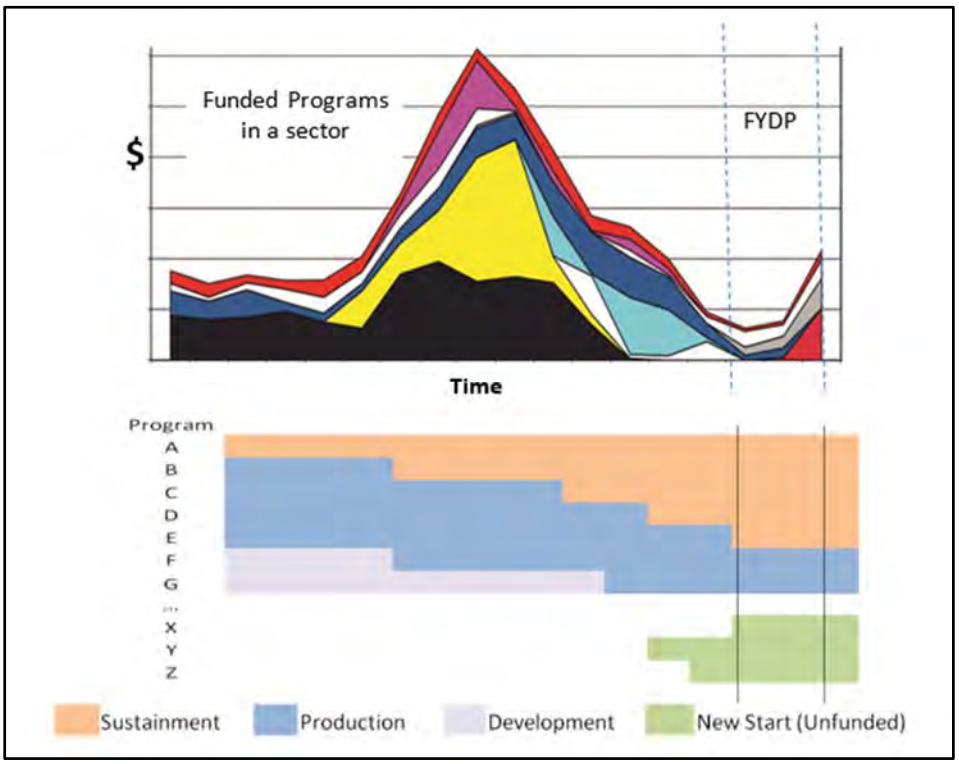

Figure 4. DoD Funding and Program View for a Notional Sector

Taken together, the high-level screens presented in this section can quickly lead the analyst to areas of highest concern and provide justification for keeping or setting aside some parts of the taxonomy.

Closing Comments

The Guidebook provides the framework and guidelines for evaluating the need for government action to preserve industrial capabilities vital to national security. In the current fiscal environment, reduced DoD procurement affects prime vendor decisions on how to absorb cuts, and their decisions flow down to the sub-tier suppliers. The fundamental questions from an industrial base perspective in deciding what and where to make cuts are as follows: Will a capability that is needed to support the warfighter be available during a downturn and at the next upturn? Will the industrial base support the next generation of innovation?

As MIBP executed the 2014 assessments, additional questions surfaced, including, for example, What is the impact of sequestration on the industrial base? Can the DoD design and produce the next generation system? Can we increase production rates if needed? The filters have proven to be adaptable. So, instead of a single, monolithic, filtering sequence, we soon realized that different questions required different filters to permit a manageable assessment. And for every question, there is a corresponding data set that is necessary to answer that question.

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